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Urea as a Partial Replacement of Protein in Diet for Milk Goats

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Due to the action of the microorganisms in the rumen of sheep, cattle and goats, the nutritive requirements of these animals differ considerably from the non-ruminants or simple stomach animals. In addition to the action of the microorganisms in the digestion of fiberous feedstuffs, they can also synthesize certain vitamins, alter natural feedstuff proteins and synthesize proteins from non-protein nitrogen compounds.

For a number of years experiments have shown that urea and other non-protein nitrogen containing compounds can be used to replace a portion of the protein in diets for ruminants, with varying degrees of success. From the practical feeding angle these experimental observations can result in considerable profit to the livestock producer.

The supply of conventional protein concentrates has often been inadequate in recent years and high in cost and with the increasing livestock production combined with better feeding practices by the farmer, this situation would appear to become worse rather than improve in the future. Even during times of adequate protein supply these concentrates must, in general, be purchased by the livestock producer and protein is usually the most expensive single ingredient in the diet. Theoretically, urea can be produced in unlimited quantities and at a cost well below that for the same protein equivalent from conventional protein feedstuffs.

A large amount of experimental work has been done in studying the use of urea in diets for sheep and cattle, however, little work has been conducted with milk goats. Dr. J. T. Reid (J. Dairy Sci., Sept. 1953, Vol. 36, No. 9, pp. 955-996) has recently reviewed the extensive literature and has drawn the following conclusions:

(1) From the data considered as a whole (lambs and young cattle) urea is somewhat inferior to conventional protein supplements as a source of nitrogen for growth.

(2) Urea has not been a consistently effective substitute for protein in the diets of fattening lambs. Some data indicate that up to 25% of the diets containing 12% protein equivalent may be satisfactorily supplied by urea, but the feeding of urea at levels providing more than 25% of the nitrogen or when used in diets containing more than 12% protein equivalent has resulted in rather poor utilization of the urea.

(3) There is some evidence that a level of 1% urea in concentrate diets for fattening calves may be sufficiently unpalatable to reduce feed intake.

(4) Urea has been found to be a satisfactory substitute for about one-third of the nitrogen in diets for pregnant and lactating ewes.

(5) The results of a large number of long-time experiments with an appreciable number of dairy cattle have indicated that urea is a satisfactory replacement for conventional protein (fed at levels up to 2/3% of the required nitrogen) from the standpoint of milk yield and the maintenance of body weight. When used at levels up to 2/3% of the required nitrogen, no abnormal effects have been found in reproductive behavior, composition of the milk or general health. From a practical standpoint urea may safely compose up to 3% of the concentrate portion of the diet or up to 1% of the total diet for lactating dairy cattle.

Theoretically, urea should produce similar results when used in diets for milk goats, however, practical feeding tests were necessary to determine the value of urea as a partial protein replacement in diets for growth, gestation and lactation of milk goats. As palatability has been a problem at times when using urea diets for the feeding of calves, it was thought that this might be an acute problem with goats due to the fact that they are generally quite choosy in their eating habits. On the other hand, it was possible that urea might prove more useful for the growth of kids than for lambs because of the slower growth rate of kids and the much lower protein requirement for hair growth over that for wool production. To answer some of the questions regarding the usefulness of urea in the feeding of milk goats the following experiments were set up at the Agricultural Research Center, Beltsville, Maryland.

Growth Experiment

On November 5, 1953, 24 head of growing Toggenburg doe kids were divided into two lots. The division being made on the basis of weight, previous gain and genetic background. During the course of the experiment the two lots were handled in an identical manner except that one group received a concentrate mixture containing urea while the other group received a concentrate mixture containing linseed oil meal. The composition of the two concentrate diets is given as follows:

Control Diet - 16% Protein

Ground yellow corn	20 percent
Ground barley	30 "
Wheat bran	19 "
Blackstrap molasses	10 "
Linseed oil meal	20 "
Iodized salt	0.75 "
Bonemeal	0.25 "

Experimental Diet - 16% Protein Equivalent

Ground yellow corn	37.8 percent
Ground barley	30.0 "
Wheat bran	19.0 "
Blackstrap molasses	10.0 "
Urea (feeding grade)	2.2 "
Iodized salt	0.75 "
Bonemeal	0.25 "

As urea contains no energy, the corn was increased to offset the loss of energy supplied by the linseed oil meal in the control diet. Both of the mixtures were pelleted using a 3/16 inch die.

On November 5 all animals received 1/2 pound of concentrate, 1 pound of alfalfa hay, and 2 pounds of orchard grass hay per day. The alfalfa hay contained 15.05% crude protein and the grass hay 6.69%. On November 9 the concentrate was increased to 3/4 pound per day, and on November 16, 1/2 pound of corn silage was added to the daily diet. The concentrate was increased to 1 pound per day on December 1 but was cut back to 3/4 pound on February 6. All animals had access to pasture from April 15 on. No other change was made in the diets until June 1 when the feeding of hay and silage was discontinued and the only roughage available being pasture. The weight record of the growing kids from November 5, 1953 to July 29, 1954, when the experiment was discontinued is given below:

Weight Record of Growing Doe Kids (pounds) Control Group (Linseed Oil Meal)

Animal	11-5-53	12-18-53	1-15-54	2-12-54	3-12-54	4-4-54	5-7-54	6-4-54	7-2-54	7-29-54
6H	63.0	70.0	71.0	68.0	72.0	74.0	75.0	85.0	89.0	93.0
55H	43.0	48.0	53.0	53.0	58.0	62.0	62.0	65.0	66.0	71.0
52H	53.0	55.0	58.0	62.0	59.0	61.0	70.0	74.0	60.0	81.0
1H	50.0	51.0	53.0	51.0	54.0	58.0	56.0	54.0	Died	
27H	46.0	51.0	50.0	Died						
69H	41.0	48.0	50.0	54.0	60.0	61.0	69.0	73.0	80.0	88.0
42H	49.0	57.0	63.0	59.0	62.0	64.0	74.0	78.0	59.0	90.0
40H	56.0	59.0	60.0	61.0	62.0	65.0	62.0	76.0	67.0	70.0
45H	53.0	55.0	56.0	60.0	62.0	64.0	67.0	68.0	Died	
51H	48.0	53.0	53.0	57.0	61.0	61.0	69.0	77.0	59.0	84.0
31H	52.0	53.0	54.0	Died						
4H	49.0	55.0	63.0	65.0	71.0	74.0	83.0	90.0	94.0	97.0
Av.Weight:	50.2	54.6	56.9	59.0	62.1	64.4	68.7	74.0	71.8	84.3
Av.Total Gain		4.4	6.7	8.8	11.9	14.2	18.5	23.8	21.6	34.1

Experimental Group (Urea)

Animal	11-5-53	12-18-53	1-15-54	2-12-54	3-12-54	4-4-54	5-7-54	6-4-54	7-2-54	7-29-54
49H	52.0	60.0	60.0	66.0	70.0	74.0	78.0	74.0	84.0	90.0
36H	53.0	57.0	56.0	54.0	60.0	62.0	73.0	77.0	78.0	84.0
18H	51.0	57.0	58.0	Died						
22H	60.0	66.0	64.0	66.0	64.0	71.0	79.0	84.0	87.0	95.0
54H	48.0	52.0	53.0	58.0	66.0	69.0	78.0	83.0	85.0	92.0
43H	50.0	55.0	55.0	54.0	59.0	61.0	66.0	80.0	75.0	80.0
47H	44.0	45.0	44.0	47.0	49.0	51.0	54.0	55.0	55.0	62.0
25H	54.0	59.0	61.0	64.0	68.0	68.0	79.0	81.0	85.0	90.0
10H	48.0	53.0	53.0	58.0	62.0	64.0	74.0	80.0	81.0	90.0
70H	41 .0	47.0	45.0	50.0	56.0	59.0	67.0	73.0	78.0	85.0
14H	53.0	58.0	58.0	63.0	64.0	65.0	69.0	70.0	72.0	81.0
53H	45.0	50.0	50.0	53.0	54.0	57.0	61.0	64.0	66.0	70.0
Av. Weight	49.9	54.9	54.8	57.5	61.5	63.7	70.7	74.6	76.9	83.5
Av. Total Gain		5.0	4.9	7.6	11.6	13.8	20.8	24.7	27.0	33.6

Gestation and Lactation Experiment

On November 18, 1953, 30 head of mature and yearling Toggenburg does were divided into 2 groups on the basis of former milk production, or milk production of their dams, age and length of gestation period. The data used for the division of the animals is given as follows:

Group 1 - Does

Number	Age	Previous Milk Production	Production in Days	Length of Gestation Period
5D	5 yrs.	802.8	189.0	49 days
36D	5 yrs.	857.0	150.0	48 "
50D	5 yrs.	979.3	188.5	53 "
48F	3 yrs.	465.5	161.0	48 "
46F	3 yrs.	816.4	179.0	53 "
25F	3 yrs.	870.6	201.0	Not bred
269	3 yrs.	660.3	201.5	49 days
39A	8 yrs.	1289.5	205.5	15 "
	4.4	843	184	45

Yearling Does

Number	Age	Dam	Dam's Production	Length of Gestation Period
39G	2 yrs.	18E	656.6	31 days
12G	2 yrs.	35D	909.7	56 "
43G	2 yrs.	32C	171.2	35 "
24G	2 yrs.	27B	746.6	34 "
19G	2 yrs.	43D	612.7	31 "
28G	2 yrs.	23D	907.8	Not bred
31G	2 yrs.	50D	979.3	Not bred
			712	37

The composite for milk production of the mature does and of the dams of the yearling does was 782 pounds. The composite for gestation time was 42 days and 3 animals not bred.

Group 2 - Does

Number	Age	Previous Milk Production	Production in Days	Length of Gestation Period
25D	5 yrs.	1317.3	188.5	18
43D	5 yrs.	612.7	183.5	52
35D	5 yrs.	909.7	187.5	55
8F	3 yrs.	426.5	181.0	56
37F	3 yrs.	818.4	198.0	56
36F	3 yrs.	608.8	195.5	Not bred
33E	4 yrs.	1216.0	187.5	53
78	5 yrs.	1080.1	144.5	11
	4.1	874	183	43

Yearling Does

Number	Age	Dam	Dam's Production	Length of Gestation Period
11G	2 yrs.	35D	909.7	53
38G	2 yrs.	18E	656.6	56
6G	2 yrs.	22D	599.6	53
10G	2 yrs.	34D	451.2	52
9G	2 yrs.	54D	813.3	15
29G	2 yrs.	5D	802.8	Not bred
20G	2 yrs.	43D	612.7	Not bred
			692	46

The composite for milk production of the mature does and of the dams of the yearling does was 789 pounds. The composite for gestation time was 44 days with 3 animals not bred.

Group 1 received the control diet or concentrate containing linseed oil meal while group 2 received the diet containing urea. The concentrate mixtures were the same as described under the growth experiment. The basic diet per doe was 1 pound of concentrate, 1½ pounds alfalfa hay, 2 pounds of orchard grass hay, and 1 pound of corn silage per day, until February 14, 1954, when the concentrate was increased to 1½ pounds per day. Further increases in the feeding of the concentrate in allowance for milk production was made on the following basis; 0.25 pounds of additional concentrate was allowed each doe for every pound of milk produced in excess of 4 pounds per day. All animals had access to pasture from April 15 on. The only other change in the feeding schedule was made on June 1, 1954, when the feeding of silage was discontinued. At kidding time the kids were removed from the does and each doe milked for a period of 120 days.

The weight record of the does from November 20, 1953 until June 4, 1954 is given as follows:

Control Diet (Linseed Oil Meal). Weight in pounds

Doe	11-20-53	12-18-53	1-15-54	2-12-54	3-12-54	4-9-54	5-7-54	6-4-54
5D	136	140	147	161	137	138	138	140
39A	128	128	137	147	153	145	136	123
25F	106	107	112	111	117	118	128	134
36D	115	117	124	140	130	132	126	128
46F	90	77	80	85	88	91	92	100
269	80	86	94	118	92	92	87	95
31G	83	82	81	81	85	87	92	97
48F	87	90	101	115	100	102	96	99
28G	87	88	87	102	112	114	135	112
19G	95	101	107	115	128	119	102	105
50D	106	107	116	126	107	109	106	120
12G	77	77	79	85	75	78	77	85
24G	85	92	101	113	98	99	96	102
39G	71	68	70	76	81	83	99	81
43G	80	78	81	79	76	79	80	90
Av.Weight	95.1	95.9	101.1	110.3	105.3	105.7	106.0	107.4

Experimental Diet (Urea)

35D	140	140	148	159	126	129	125	125
78	115	110	119	135	143	119	104	116
25D	111	108	113	121	134	137	126	130
33E	118	120	130	146	119	117	115	131
11G	102	106	113	135	104	106	106	113
36F	85	73	73	77	72	73	73	75
37F	104	110	119	143	109	109	88	103
6G	75	76	81	97	74	74	83	89
8F	104	110	115	140	101	100	103	106
43D	102	103	106	114	103	104	99	100
38G	77	76	82	87	77	78	76	81
29G	95	95	96	100	102	104	116	121
10G	120	120	128	145	135	Discontinued		
20G	93	89	91	97	98	94	106	112
9G	83	85	87	97	102	96	91	98
Av. Weight	101.6	101.4	106.7	119.5	106.6	103.2	100.8	107.1

Eleven does on the control diet kidded and 12 does on experimental diet. The kidding record for the two groups is as follows:

Control Diet (Linseed Oil Meal)

Doe Number	Kidding date	Number of kids	Sex and weights	Total weight of kids
12G	2-18	1	D= 6.0	6.0
269	2-14	2	B=6.6 and D=7.5	14.1
50D	2-20	2	D=7.1 and D=6.0	13.1
48F	2-22	2	B=5.5 and D=3.5	9.0
5D	2-26	2	B=8.3 and B=8.0	16.3
36D	2-28	2	B=8.1 and D=6.0	14.1
24G	3-10	2	B=7.0 and D=5.7	12.7
19G	3-14	2	B=6.6 and D=5.5	12.1
39A	3-30	1	B=8.0	8.0
28G	5-9	2	B=5.5 and D=4.4	9.4
39G	5-15	2	D=5.0 and D=4.8	9.8
	Total	20		124.6 pounds
			Average weight of kids	6.2 pounds

Experimental Diet (Urea)

8F	2-14	2	B=8.2 and D=6.3	14.5
35D	2-15	2 & 1 dead	B=4.8 and D=5.7	10.5
37F	2-16	3	B=6.6, D=6.5 & D=5.2	18.3
38G	2-16	1	B=7.6	7.6
33E	2-19	2	B=9.2 and D=5.3	14.5
10G	2-20	1	B=9.9	9.9
11G	2-20	2	D=6.8 and D=5.0	11.8
6G	2-20	2	B=6.2 and D=6.5	12.7
43D	2-24	1	D=7.0	7.0
9G	4-2	1	B=6.9	6.9
78	4-5	3	B=8.0, B=7.1 and D=6.5	21.6
25D	4-18	1	B=9.7	9.7
	Total	21 live kids		145.0 pounds
			Average weight of kids	6.9 pounds

Each doe with the exception of 10G from the experimental group, which failed to come into milk production, was milked for a total of 120 days. At the end of 120 days milking was discontinued and the doe removed from the experiment. Each doe was milked twice daily and a record of the milk yield in pounds was obtained. A milk sample was taken for fat analysis at the end of the first five days of production and samples were regularly taken from that time on at the middle of each production month.

The milk and butterfat production record for the two groups of does is given as follows:

Control Group (Linseed Oil Meal)

Doe	Kidding date	Total Milk Production (lbs.)	Av. Daily Milk Production (lbs.)	Total Fat Production (lbs.)	4% F.C.M. 1/ Production (lbs.)
12G	2-18	329.3	2.74	8.60	260.7
269	2-19	689.9	5.75	25.87	664.0
50D	2-20	920.5	7.67	27.70	783.8
48F	2-22	596.2	4.97	15.80	475.5
5D	2-26	601.6	5.01	21.53	563.6
36D	2-28	619.7	5.16	21.05	563.6
24G	3-10	579.3	4.83	16.58	480.5
19G	3-14	567.2	4.73	16.89	480.2
39A	3-30	420.1	3.50	16.31	412.7
28G	5-9	280.3	2.34	8.24	235.7
39G	5-15	223.7	1.86	6.65	189.2

Total milk production = 5,827.8 pounds
Average milk production/doe = 529.8 pounds
Total fat production = 185.22 pounds
Average fat production/doe = 16.84 pounds
Total 4% F.C.M. production = 5,109.5 pounds
Average 4% F.C.M. production/doe = 464.5 pounds

1/ 4% fat corrected milk according to the Gaines-Davidson formula (FCM =0.4M + 15F, where M = weight of milk and F the weight of fat).

Experimental Group (Urea)

Doe	Kidding date	Total Milk Production (lbs.)	Av. Daily Milk Production (lbs.)	Total Fat Production (lbs.)	4% F. C. M. Production (lbs.)
8F	2-14	534.1	4.45	17.08	469.8
35D	2-15	780.4	6.00	21.87	640.2
37D	2-16	792.1	6.10	29.11	753.7
38G	2-16	353.6	2.95	10.42	297.7
33E	2-19	1210.3	10.09	37.68	1049.3
11G	2-20	586.2	4.88	16.72	485.3
6G	2-20	149.4	1.24	3.94	118.9
43D	2-24	230.4	1.92	8.37	217.7
9G	4-2	521.8	4.35	8.39	334.6
78	4-5	1067.1	8.89	22.16	759.2
25D	4-18	1232.4	10.27	35.23	1021.4

Total milk production = 7,457.8 pounds

Average milk production/doe = 678.0 pounds

Total fat production = 210.97 pounds

Average fat production/doe = 19.18 pounds

Total 4% F. C. M. production = 6,147.8 pounds

Average 4% F. C. M. production/doe = 558.9 pounds

Summary

Urea has been used to supply 36 percent of the protein equivalent in the concentrate diet for growth, gestation and lactation of milk goats with comparable results to that obtained with the use of linseed oil meal to supply the same protein equivalent. In none of the tests did the urea containing diet prove inferior to the diet containing linseed oil meal. Palatability was not a problem in any of the tests, i.e., in all cases the animals consumed the urea containing concentrate as readily as they did the concentrate containing linseed oil meal. Although every attempt was made to equalize the does selected for the lactation test, the factors affecting milk production in addition to nutrition are so complex that the increased milk production of the group receiving the urea diet should not be interpreted that urea is superior to linseed oil meal for milk production, however, the results of this test do indicate that urea can be used in diets for lactating does with very satisfactory results.

In the feeding trials described 2.2 pounds of urea plus 17.8 pounds of yellow corn replaced 20 pounds of linseed oil meal in the concentrate mixture. The economy of feeding urea would depend on the relative costs of the three ingredients. Using the price figures of feed delivered at the Agricultural Research Center, the urea plus corn for each ton of concentrate, cost $17.80 as compared to $18.20 for the linseed oil meal.

In practical feeding work the following facts should be taken into consideration before one attempts to feed urea:

(1) Urea is toxic to animals in large quantities. It should not comprise more than 1 percent of the total diet or more than 3 percent of the concentrate mixture. Urea must be well mixed with the other constituents of the diet to prevent the animals from consuming excessive amounts.

(2) Urea contains no energy while conventional protein supplements are good sources of energy. This fact needs to be taken into consideration when balancing diets.

(3) Urea should only be considered as a replacement for expensive protein supplements and its use should result in reducing feed costs.